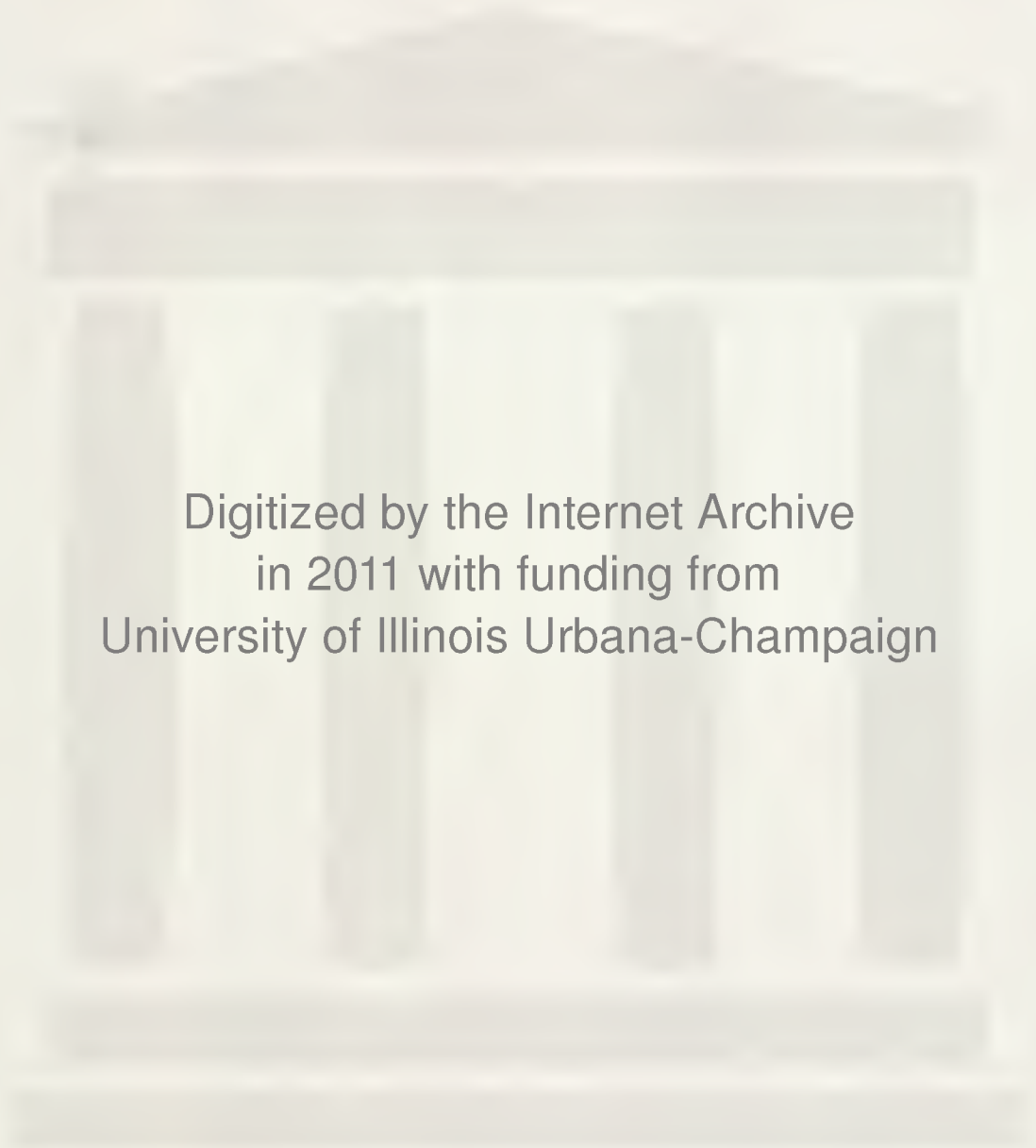

Faculty Working Papers

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Summary

A questionnaire survey was conducted covering 75 on-line terminal operators at a large gas utility. They were asked to give preference ratings to alternative arrangements with regard to panelling, seating, background music, and the location of a terminal on the desk. The majority of the respondents preferred an open space layout to layouts with some panels, and some background music to no music. These results are in conformity with the findings of most past studies. As to seating arrangements, they gave the highest preference to a random arrangement made independent of the employee's sex or seniority. With respect to the location of a terminal, the lefthand side of the operator was rated highest by about half of the respondents, and the center of the desk by one quarter of them.

## Introduction

This paper reports the result of a questionnaire survey of 75 on-line terminal operators who received and processed customer telephone calls for various requests at a large gas utility. The purpose of the survey was to find their preference ratings of alternative arrangements of panelling, seating, background music, and the location of a terminal on the desk.

A growing number of organizations have been adopting on-line computer systems to their office operations, replacing manual clerical jobs with jobs operating an on-line terminal. The installation of a large number of on-line terminals enmass makes the office less personable and look more like a factory assembly line. In the traditional office, clerks usually perform manual work under their own control, sitting side by side or face to face. They are free to look at one another or carry out conversations. In the modern office with on-line terminals, operators perform their work through terminal keyboards under machine paced control, gazing at a video-tube in close distance throughout the day. In general, their views are obstructed by terminals even in an open space office and they are not as free to carry out conversations with colleagues as in the traditional office. In extreme cases, each terminal operator is placed in an individual booth isolating him or her from the surroundings.

Earlier, Parsons (1970) indicated that most human factors studies in computerized information systems had been limited to manual entry problems, but that work was also needed on displays, integrated entry-display, work-space and other equipment aspects, on-line languages, and

program production. His statement was indictive of the conditions that existed those years, but is also applicable to the present conditions. Most existing studies concerning on-line terminal operators seemed to be limited to the subject of human problem solving behavior at an on-line terminal (see, for example, Sackman [12] [13]). The problem of panelling is closely related to the problem of office space. Although most articles written in English on the subject of office space are subjective arguments, one noteworthy study was reported by Namecek and Grandjean [10]. They conducted a survey asking 519 employees in 15 large space offices (a large office was defined as a room with 20 people or more.) The result of the survey indicated that the majority, 63%, of the respondents preferred a large space office to a smaller space office.

Early studies of the effects of noise on complex activities did not produce conclusive results (Broadbent [1]). Similarly, subsequent studies (Broadbent [2], Kryter [8]) on the effects of noise on vigilance, response time, visual search speed and ability to solve simple arithmetic problems did not produce conclusive results. Other studies found that noise would negatively affect performance if subjects were required to carry out several tasks simultaneously (Finkelman and Glass [3], Hockey [6] [7], Woodhead [17]). The result of an experiment conducted by Weinstein [14] showed that noise did not affect performance in detecting spelling errors, but that it did affect performance in identifying grammatical errors. He concluded that the effects of noise was so complex that laboratory experiments not duplicating real-life conditions would not produce useful results.

As to background music, earlier Wokoun [15] reported favorable effects produced by background music on subjects at vigilance task, but later he concluded that the effects of background music were inconclusive (Wokoun [16]). Murrell [9] stated that the effects of background music on the performances of industrial people are inconclusive, although the majority of them preferred to have it. Gladstone [4] conducted an experiment to measure the effects of background music on the performance of operators of keyboard data-preparation equipment. His conclusion was that background music had no significant sustained effect on either work rates or error rates, although the majority of the operators preferred to have the music. Recently, Young and Berry [18] conducted an experiment and concluded that subjects preferred low-level music or nature sounds to a totally quiet office, but that the introduction of music or nature sounds in concert with random-pattern noise, such as in a very noisy office, tended to accentuate the undesirable effects of the noise.

The company discussed in this study was a utility company distributing gas to approximately one million families in one of the largest cities in this country (Hinomoto [5]). The Customer Relations Department of the Sales Division processed regular customer orders on meter connections and disconnections, and emergency customer orders on gas leaks and poor supplies, or answered customers questions regarding monthly bills. Practically all these orders and questions were sent by telephone and received by business representatives in the downtown main office. Received orders were channeled to three service shops for dispatching servicemen.

Previously, customer orders were manually processed by 154 business representatives. These people were divided into 22 groups of seven who sat around a circular work station with a rotating file of customer master cards containing information on customer premise and account. Each group of business representatives at a specific station had a specific telephone number and handled a block of customer accounts. An incoming call is picked up and processed by any free business representative at the station. In the middle of the 1970s, the manual system was replaced by an on-line computer system. In the new system, one phone number was used for all customer calls regardless of account numbers. Through an on-line terminal, any business representative had a direct access to an on-line customer file, and entered the order directly into the computer system. Because of the faster processing of a customer telephone call, the new system required only a work force of 80 business representatives instead of the previous 154. The management of the Customer Relations Department was concerned with the efficient use of the new system in which the company had invested about 4 million dollars. One of the matters the management was concerned with was the work station layout and environment of the business representative in the new office, since it had been the first time for the company to install so many on-line termianls in one room.

## Environment of the New System

For the purpose of supervision, the 80 business representatives were divided into 4 groups of 20 each under one supervisor. Unlike the previous system, the new, on-line system imposed no constraint on

the seating arrangement for business representatives, since all of them could have access to an on-line master file storing the entire customers data through their terminals. These groups occupied a large, open L-shaped floor space with each wing being occupied by two groups in tandem without walls separating them. Members of each group sat in five rows of four people each, facing abreast toward the corner. The ceiling height of the office was lowered when new suspended panels had been installed to improve the office appearance. The lower height and material of the new ceiling enhanced the noise level in the office by the increased reflection of the telephone conversations of business representatives.

While business representatives of this company processed an average of 95 calls per person per day, another utility serving adjoining areas used a similar on-line system staffed by business representatives working at booth-type stations with panels on three sides processed an average of 110 calls per person per day. Since a close attention was required to work with the new system, the management suspected the high noise level as a possible cause for the lower efficiency of their employees as compared with the efficiency of the neighboring utility's employees. They hoped to find the most desirable layout and environment of the work station of the business representative.

## Questionnaire Survey

A questionnaire survey was conducted asking business representatives to give their preference ratings of alternative arrangements of panels in

the office, alternate seating arrangements, background music, and alternative locations of the terminal on the desk top. The questionnaire was answered by all 75 business representatives consisting of 40 females and 35 males present on the job. The age distributions of female employees and male employees as percentages of each group were very similar to each other, as is shown in Table 1.

A typical business representative would be a male or female who had had a minimum of two years of some office work after finishing a high school. Business representatives were paid better than most other clerical personnel in the company. New business representatives went through a training program lasting two months. The on-line processing of customer orders made the training simpler than under the previous system using card files. After the on-line system was installed, only those who had some typing experience were hired because of the close similarity between keying a computer terminal and keying a typewriter.

1. Panelling Arrangements

Concerned with a higher noise level in the new work environment, the management considered the possibility that business representatives might prefer a more quiet environment. Consequently, they were asked to rank the following alternative panelling arrangements:

a. layout 1: open space without panel

b. layout 2: panels separating groups of 20 people each

c. layout 3: panels separating every two rows of 5 people each

d. layout 4: panels separating every row

e. layout 5: panels around each individual

Before the survey, the management was worried about the possibility that the majority of the business representatives might rate the layout with individual booths as the most desirable, because that would cost the company a large sum of money for the conversion. But, the management's worry was unwarranted. The business representatives gave the existing open space without panel the highest average preference rating and a lower average rating to a layout with more panels. The preference order of alternative layouts by the female group was very similar to that order by the male group, as is given by the weighted average ratings of the two groups in Table 2. To the management's surprise, the majority in each group rejected the individual booth as the least desirable. This result seems to support the result of a survey reported by Namecek and Grandjean [10]: "the large space office has advantages because of better communication and improved personal contact; and 63% of the respondents have judged the course of work in the large space office as easier and more practical."

On the righthand side of Table 2, we have listed the result of the computation of t statistic to determine if there is a significant difference between the average ratings of each type of paneling by the female and male groups. For all types of paneling except the panels between groups, the resulting t statistic is less than 1.645, meaning that the difference between the two average ratings is statistically insignificant for a confidence level of 0.1 in two-tail test.

2. Seating Arrangements

This investigator has found no noteworthy study on the subject of seating arrangements. The existing seating arrangement in the new

office was a random arrangement in which the seating locations of business representatives were made without special consideration given to the sex or seniority of each person. A question was designed to assess the preference order of the following five alternative seating arrangements in terms of the sex or seniority of each person within a row:

a. a random arrangement that does not give a special consideration to each employee's sex or seniority
b. an employee of higher seniority and that of lower seniority alternately sitting in each row
c. employees of similar seniority sitting in each row
d. a female and a male employee alternately sitting in each row
e. employees of the same sex sitting in each row.

The distribution of preference ratings given to the five alternative arrangements is presented in Table 3. In terms of the average rating of all respondents, the preference order of the alternative seating arrangements was: (1) the random seating arrangement, (2) the arrangement in which a male and a female alternately sitting in each row, (3) employees of the same sex sitting in each row, (4) the arrangement in which a junior and a senior in seniority alternately sitting in each row, and (5) the arrangement in which employees of a similar seniority sitting in each row.

The both sex groups considered the random arrangement as the first preference, and the arrangement in which a female and a male employees alternate in each row as the second preference. But, for the remaining

arrangements, the two groups gave different preference orders. Their disagreement was smallest on the arrangement in which junior and senior employees alternately sit in each row, and greatest on the arrangement in which employees with similar seniority sit in each row.

The resulting t statistics for all the seating arrangements except for the arrangement in which employees with similar seniority sit in each row are less than 1.645, indicating that there is no significant difference between the average ratings of the male and female groups at a confidence level of 0.1.

3. Background Music

The business representatives were asked whether they liked to have background music. As is shown in Table 4, fifty seven or 76% of the 75 respondents preferred to have background music. This result is in agreement with past studies, as has been discussed previously. A comparison of the average ratings of the male and female groups has produced a t statistic indicating an insignificant difference at a confidence level of 0.1. Only four said they did not want to have background music; interestingly, they were all females.

4. Location of a Terminal

The business representative's work required a small amount of form filling. This requirement was considered to affect his or her preference about the location of a terminal on the desk. The preference would in turn depend on the hand dexterity of the business representative. The systems and procedures people who had designed the desk and laid out the work station seemed to have ignored the fact that not all

the business representatives were right handed. Every business representative was provided with an identical desk top that had an extended wing to hold a terminal on the lefthand side of the operator.

A question asked the business representative about his or her hand dexterity and the preferred location of a terminal on the desk. The summary result of answers to the question is listed in Table 5. Ten or 16 percent of the 74 respondents were lefthanded and one person was ambi-dextrous. Of the righthanded respondents, about half or 52 percent preferred the lefthand side of the desk as the location of a terminal, and almost one quarter of them the middle of the desk. In contrast, the frequency of lefthanded respondents was very flatly distributed over different terminal locations. Interestingly, 40% of the lefthanded respondents were indifferent about the location of a terminal, perhaps because they had developed flexibility to live with work arrangements normally designed for the righthanded people.

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Table 1. Age Distribution of Repondents

| Type of Sex | Number of Respondents: 25 or less | 26 through 35 | 36 through 45 | 46 through 55 | 56 and above | not available | all respondents |
|---|---|---|---|---|---|---|---|
| Number of Respondents: | | | | | | | |
| Female | 8 | 23 | 3 | 4 | 1 | 1 | 40 |
| Male | 9 | 20 | 3 | 3 | 0 | 0 | 35 |
| Both | 17 | 43 | 6 | 7 | 1 | 1 | 75 |
| Percentage of the Group: | | | | | | | |
| Female | 20.0% | 57.5% | 7.5% | 10.0% | 2.5% | 2.5% | 100% |
| Male | 25.7 | 57.1 | 8.6 | 8.6 | 0 | 0 | 100 |
| Both | 22.7% | 57.3% | 8.0% | 9.4% | 1.3% | 1.3% | 100% |

Table 2. Preference Ratings of Paneled Work Stations

| Type of Paneling | Sex | Preference Rating* 1 | 2 | 3 | 4 | 5 | Total Respondents | Average Rating $\mu$ | Hypothesis: $\mu_F = \mu_M$ t Statistic | Two-tail Probability Value of t | Is Hypothesis Acceptable at $\alpha = 0.1$ ($t = 1.645$)? |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No Panel | F | 34 | 1 | 1 | 0 | 4 | 40 | 1.48 | | | |
| | M | 25 | 0 | 3 | 1 | 4 | 33 | 1.76 | | | |
| | Both | 59 | 1 | 4 | 1 | 8 | 73 | 1.60 | 0.9019 | 0.3702 | yes |
| Panels Between Groups | F | 2 | 22 | 0 | 2 | 0 | 26 | 2.08 | | | |
| | M | 1 | 17 | 4 | 4 | 5 | 31 | 2.84 | | | |
| | Both | 3 | 39 | 4 | 6 | 5 | 57 | 2.49 | 2.8899 | 0.0055 | no |
| Panels Every Two Rows | F | 0 | 2 | 18 | 2 | 1 | 23 | 3.09 | | | |
| | M | 2 | 5 | 19 | 3 | 1 | 30 | 2.87 | | | |
| | Both | 2 | 7 | 37 | 5 | 2 | 53 | 2.96 | 1.0865 | 0.2824 | yes |
| Panels Every Row | F | 0 | 1 | 5 | 17 | 0 | 23 | 3.69 | | | |
| | M | 3 | 5 | 4 | 18 | 1 | 31 | 3.29 | | | |
| | Both | 3 | 6 | 9 | 35 | 1 | 54 | 3.46 | 1.6148 | 0.1124 | yes |
| Individual Booth | F | 4 | 1 | 0 | 2 | 18 | 25 | 4.16 | | | |
| | M | 3 | 4 | 0 | 4 | 19 | 30 | 4.07 | | | |
| | Both | 7 | 5 | 0 | 6 | 37 | 55 | 4.11 | 0.2298 | 0.8191 | yes |

*1 = 1st preference, 2 = 2nd preference, 3 = 3rd preference, 4 = 4th preference, 5 = 5th preference.

Table 3. Preference Ratings of Seating Arrangements by Sex

| Type of Arrangement by Sex or Seniority | Sex | Preference Rating* 1 | 2 | 3 | 4 | 5 | Total Respondents | Average Rating $\mu$ | Hypothesis: $\mu_F = \mu_M$ t Statistic | Two-Tail Probability Value of t | Is Hypothesis Acceptable at $\alpha = 0.1$ ($t = 1.645$)? |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Random Arrangement | F | 34 | 1 | 2 | 1 | 0 | 38 | 1.21 | | | |
| | M | 29 | 1 | 0 | 2 | 0 | 32 | 1.22 | | | |
| | Both | 63 | 2 | 2 | 3 | 0 | 70 | 1.21 | 0.0486 | 0.9614 | yes |
| Female and Male Employees Alternating in Each Row | F | 5 | 12 | 6 | 2 | 1 | 26 | 2.31 | | | |
| | M | 3 | 17 | 7 | 2 | 1 | 30 | 2.37 | | | |
| | Both | 8 | 29 | 13 | 4 | 2 | 56 | 2.33 | 0.2322 | 0.8172 | yes |
| Junior and Senior Employees Alternating in Row | F | 0 | 6 | 8 | 3 | 7 | 24 | 3.45 | | | |
| | M | 1 | 5 | 7 | 9 | 7 | 29 | 3.59 | | | |
| | Both | 1 | 11 | 15 | 12 | 14 | 53 | 3.53 | 0.3928 | 0.6961 | yes |
| Employees with Similar Seniority in Each Row | F | 0 | 1 | 3 | 16 | 4 | 24 | 3.96 | | | |
| | M | 0 | 3 | 10 | 13 | 2 | 29 | 3.55 | | | |
| | Both | 0 | 4 | 13 | 29 | 6 | 52 | 3.53 | 1.9840 | 0.0527 | no |
| Employees of Same Sex in Each Row | F | 0 | 6 | 5 | 12 | 16 | 24 | 3.79 | | | |
| | M | 1 | 3 | 6 | 18 | 5 | 30 | 4.10 | | | |
| | Both | 1 | 9 | 11 | 30 | 21 | 54 | 3.96 | 0.8824 | 0.3816 | yes |

*1 = 1st preference, 2 = 2nd preference, 3 = 3rd preference, 4 = 4th preference, 5 = 5th preference.

Table 4. Preference Ratings on Background Music

| Sex of Respondent | Number of Respondents (Preference Rating*) 1 | 2 | 3 | 4 | 5 | Total | Average Rating $\mu$ | Hypothesis: $\mu_F = \mu_M$ t Statistic | Two-tail Probability Value of t | Is Hypothesis Acceptable at $\alpha = 0.1$ ($t = 1.645$)? |
|---|---|---|---|---|---|---|---|---|---|---|
| F | 16 | 14 | 6 | 4 | 0 | 40 | $\mu_F = 1.95$ | | | |
| M | 9 | 18 | 8 | 0 | 0 | 35 | $\mu_M = 1.97$ | | | |
| Both | 25 | 32 | 14 | 4 | 0 | 75 | 1.96 | 0.1068 | 0.9153 | yes |

*1 = Definitely yes, 2 = Yes, 3 = Neutral, 4 = No, 5 = Definitely no.

Table 5. Desired Location of Video Terminal on Desk-Top

| Type of Hand Dexterity | Number of Respondents (Location of Terminal) On the Lefthand | In the Middle | On the Righthand | Indifferent | Total |
|---|---|---|---|---|---|
| Number of Respondents: | | | | | |
| Righthanded | 33 | 15 | 5 | 10 | 63 |
| Lefthanded | 2 | 2 | 2 | 4 | 10 |
| Ambi-Dextrous | 1 | 0 | 0 | 0 | 1 |
| All Types | 36 | 17 | 7 | 14 | 74 |
| Percentage of the Group: | | | | | |
| Righthanded | 52.4% | 23.8% | 7.9% | 15.9% | 100% |
| Lefthanded | 20.0 | 20.0 | 20.0 | 40.0 | 100 |
| Ambi-Dextrous | 100.0 | 0.0 | 0.0 | 0.0 | 100% |
| All Types | 48.6% | 23.0% | 9.5% | 18.9% | 100% |